

Report No. DOT/FAA/RD-81/95
DOT/FAA/CT-81/79



LEVEL

IN-SERVICE TESTING OF THE PRECISION APPROACH PATH INDICATOR (PAPI) AT NEWARK INTERNATIONAL AIRPORT, NEW JERSEY

Bret B. Castle

**FEDERAL AVIATION ADMINISTRATION TECHNICAL CENTER
Atlantic City Airport, New Jersey 08405**



B

INTERIM REPORT

DECEMBER 1981

Document is available to the U.S. public through
the National Technical Information Service,
Springfield, Virginia 22161.

Prepared for

**U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
Systems Research & Development Service
Washington, D. C. 20590**

01 20 82 012

AD A109843

DTIC FILE COPY

NOTICE

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no liability for the contents or use thereof.

The United States Government does not endorse products or manufacturers. Trade or manufacturer's names appear herein solely because they are considered essential to the object of this report.

Technical Report Documentation Page

1. Report No. DOT/FAA/RD-81/95	2. Government Accession No. AD A107 195	3. Recipient's Catalog No.	
4. Title and Subtitle IN-SERVICE TESTING OF THE PRECISION APPROACH PATH INDICATOR (PAPI) AT NEWARK INTERNATIONAL AIRPORT, NEW JERSEY		5. Report Date December 1981	
		6. Performing Organization Code	
7. Author(s) Bret B. Castle		8. Performing Organization Report No. DOT/FAA/CT-81/79	
9. Performing Organization Name and Address Federal Aviation Administration Technical Center Atlantic City Airport, New Jersey 08405		10. Work Unit No. (TRAIS)	
		11. Contract or Grant No. 081-502-510	
12. Sponsoring Agency Name and Address U.S. Department of Transportation Federal Aviation Administration Systems Research and Development Service Washington, D.C. 20590		13. Type of Report and Period Covered Interim Report Dec. 8, 1980 to April 8, 1981	
		14. Sponsoring Agency Code	
15. Supplementary Notes "NAFEC" referenced in this report is now known as the FAA Technical Center.			
16. Abstract This report covers that portion of the Precision Approach Path Indicator (PAPI) tests involving 4 months of in-service testing at Newark International Airport, New Jersey. Basically, the PAPI was compared against the standard red/white Visual Approach Slope Indicator (VASI) system at a large airport and on a runway with an Instrument Landing System (ILS). The PAPI system was installed in a manner to take care of aircraft of all sizes; that is, different wheel-to-eye distances. The information was obtained from pilots of large commercial aircraft. Questionnaires from general aviation aircraft pilots were not used for this particular report. Results showed that under these conditions about 60 percent of the pilots (a total of 117 questionnaires) preferred the PAPI over the VASI system.			
17. Key Words PAPI Visual Aids VASI ILS Wheel-to-Eye Distance In-Service Testing		18. Distribution Statement Document is available to the U.S. public through the National Technical Information Service, Springfield, Virginia 22161	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 9	22. Price

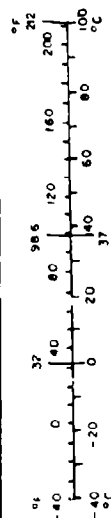
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
LENGTH				
in	inches	2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
m	miles	1.6	kilometers	km
AREA				
m ²	square inches	6.5	square centimeters	cm ²
ft ²	square feet	0.09	square meters	m ²
yd ²	square yards	0.8	square meters	m ²
mi ²	square miles	2.6	square kilometers	km ²
	acres	0.4	hectares	ha
MASS (weight)				
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons	0.9	tonnes	t
VOLUME				
teaspoon	teaspoon	5	milliliters	ml
fluid ounce	fluid ounces	15	milliliters	ml
cup	cup	30	milliliters	ml
quart	quarts	0.25	liters	l
gallon	gallons	0.47	liters	l
quart	quarts	0.95	liters	l
gallon	gallons	3.8	liters	l
cubic foot	cubic feet	0.03	cubic meters	m ³
cubic yard	cubic yards	0.76	cubic meters	m ³
TEMPERATURE (exact)				
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

Approximate Conversions from Metric Measures

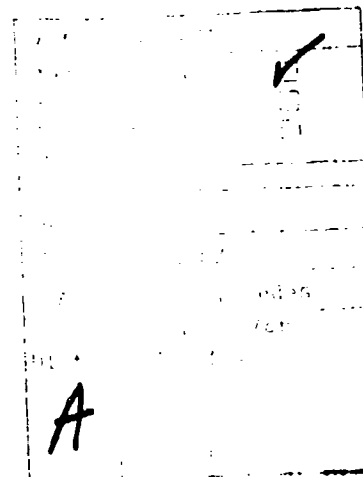
Symbol	When You Know	Multiply by	To Find	Symbol
LENGTH				
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
km	kilometers	1.1	yards	yd
		0.6	miles	mi
AREA				
cm ²	square centimeters	0.16	square inches	in ²
m ²	square meters	1.2	square yards	yd ²
km ²	square kilometers	0.4	square miles	mi ²
ha	hectares (10,000 m ²)	2.5	acres	ac
MASS (weight)				
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1,000 kg)	1.1	short tons	st
VOLUME				
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m ³	cubic meters	35	cubic feet	ft ³
m ³	cubic meters	1.3	cubic yards	yd ³
TEMPERATURE (exact)				
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



Copyright © 1994 by The McGraw-Hill Companies, Inc. All rights reserved. Printed in the United States of America. This book is a trademark of The McGraw-Hill Companies, Inc.

TABLE OF CONTENTS

	Page
INTRODUCTION	1
Purpose	1
DISCUSSION	1
General	1
Equipment	1
RESULTS	1
Test	1
Summary	3
APPENDIX	



LIST OF TABLES

Table		Page
1	Percentage of Types of Aircraft	2
2	A Percentage Comparison of PAPI with VASI	2

INTRODUCTION

PURPOSE.

The Precision Approach Path Indicator (PAPI) system is a visual glidepath indicator similar to the standard Visual Approach Slope Indicator (VASI) system. Previous testing of PAPI at the Technical Center has shown that the differences in PAPI over the standard VASI may be advantageous to the pilots who use the PAPI system. The purpose of this Interim Report is to document the in-service testing of the system at Newark International Airport (EWR).

DISCUSSION

GENERAL.

Four months (December 8, 1980 to April 8, 1981) of in-service testing was accomplished at EWR on runway 4R. Questionnaires (appendix) were provided to the pilots by the Air Line Pilots Association and collected by it and the Air Transport Association. The results are shown in this report.

In order to allow for the large difference in wheel-to-eye height between some small aircraft and some large aircraft, the scheme used at EWR was to move the PAPI units down the runway 300 feet beyond the Instrument Landing System (ILS) glide slope intercept point (a total of 1350 feet down from the displaced threshold at EWR), and open up the on-course signal to 30 minutes of a degree instead of the regular 20-minute segment. This allows the wheels of the small aircraft to cross the threshold at 62 feet and the wheels of the largest aircraft (B-747) to cross the threshold at 21 feet when following the bottom of the visual on-course signal.

Newark International Airport was selected to obtain data from large commercial aircraft and no general aviation testing was performed. Testing at a general aviation airport utilizing small aircraft and general aviation pilots is scheduled for a later date.

EQUIPMENT.

The PAPI equipment used during the EWR tests was the standard four-box model M1.6 PAPI system manufactured by the Barret Lighting Company Limited, of Stansted, England. It was installed on the right-hand side of runway 4R with the intensity controlled by a photo cell (bright during the daylight hours and dim during the hours of darkness). The system was left in the ON condition except when requested to be turned off by pilots and during low visibility conditions.

RESULTS

TEST.

During the 4 months of flight testing, a total of 117 questionnaires were returned. Basically, they compared the PAPI system to the standard red/white VASI system generally used throughout the United States. Table 1 shows the mix of aircraft used to obtain information for the tests.

Questionnaires were received from pilots of seven different aircraft types, all of which are considered transport aircraft, giving a good sampling of today's commercial aircraft. No questionnaires were received from general aviation pilots.

More than 90 percent of the flights were made with the visibility greater than 3 miles, the ceiling higher than 2000 feet, and with no precipitation. A few flights reported rain, snow, fog, cloudiness, and smog. Some 63 percent of the approaches were made during the

hours of 1600 to 2400, 34 percent during the hours of 0800 to 1600, and 3 percent during the hours of 0000 to 0800.

Table 2 shows the results of the comparison of the PAPI system with the standard red/white VASI system, in percentage form.

TABLE 1. PERCENTAGE OF TYPES OF AIRCRAFT

<u>Aircraft Type</u>	<u>% of Total</u>
B-727	42
DC-10	22
B-737	13
DC-8	9
B-747	8
L-1011	5
B-707	1

TABLE 2. A PERCENTAGE COMPARISON OF PAPI WITH VASI

	<u>BETTER</u>	<u>SAME</u>	<u>WORSE</u>
Rate Information	57	37	6
Ease of Maintaining Approach Angle	50	43	7
Correcting Vertical Excursions	57	33	10
Usefulness of Touchdown Aiming Point	40	53	7
Coincidence with ILS	40	57	3
Initial Contact Range	60	29	11
Overall Value Compared with VASI's	61	28	11

SUMMARY.

Analysis of these data show that the United States pilots were not quite as enthusiastic about PAPI as testing results have shown in England, Canada, or France. PAPI, however, was rated better than VASI in all rating factors at Newark except in the "Usefulness of Touchdown Aiming Point" and the "Coincidence with ILS." In these two cases, most pilots thought that both PAPI and VASI rated about the same.

No overall test ratings by the pilots indicated that the VASI was better than

PAPI. In the "Overall Value Compared with VASI's," 61 percent favored PAPI, 27 percent thought they were about the same and 11 percent thought the VASI was better than the PAPI. This clearly indicates that, overall, the pilots who evaluated the PAPI at Newark considered the PAPI to be an improvement over the VASI. It must be remembered that these in-service tests include only information derived from commercial pilots of large aircraft and do not include the general aviation segment of the flying public. Further testing of this type is presently in process.

APPENDIX

QUESTIONNAIRE AND SAMPLE COMMENTS

Figure A-1 is a summation of the results of the questionnaires received from the 117 pilots who flew the system at Newark. It also contains samples of the majority of comments received from the pilots.

(After completion of the approach,
please check the appropriate boxes)

EWR TEST RESULTS

Date: 12-8-80 to 4-8-81	Time: 0000-0800=3% 0800-1600=34% 1600-2400=63%	Aircraft Type:
-------------------------------	--	----------------

RVR or Visibility
on Approach

1200 to 1800	1800 to 2400	2400 to 4000	1-3 miles	> 3 miles	X
--------------------	--------------------	--------------------	-----------	-----------	---

Lowest
Clouds

100 to 200 ft.	200 to 300 ft.	300 to 500 ft.	500 to 2000 ft.	> 2000 ft.	X
----------------------	----------------------	----------------------	-----------------------	------------	---

Precipitation/Visibility Restriction

Type:

None:

X

Comparison with VASIS. Please assess PAPI on the following points:

(NUMBER OF PILOT RESPONSES)

1. Rate Information
2. Ease of Maintaining Approach Angle
3. Correcting Vertical Excursions
4. Usefulness on Touchdown Aiming Point
5. Coincidence with ILS
6. Initial Contact Range
7. Overall value compared with VASIS

Better	Same	Worse
64	42	7
56	48	8
64	38	11
44	59	8
42	61	3
67	33	12
70	31	13

FIGURE A-1. QUESTIONNAIRE WITH NEWARK TEST RESULTS (Sheet 1 of 2)

SAMPLE COMMENTS TAKEN FROM THE QUESTIONNAIRES

1. By far the vast majority of comments (at least 20) concerned the control of the brilliance of the lights. Most indicated that the white lights were too bright compared to the red lights; or the red ones were not bright enough compared to the white. Some thought both colors (red and white) were overpowering and should be dimmed.
2. At least eight comments stated that overall, the Precision Approach Path Indicator (PAPI) system is better than the Visual Approach Slope Indicator (VASI) system. Samples - "PAPI gives more precise information," and "An excellent system."
3. At least six comments concerned the rapid change in colors. Most thought this was beneficial but two preferred the subtle pink transitional area of the VASI.

QUOTED COMMENTS

1. "Since interpretation is not based on pink/red shading, the positive change of one light from white to red shows very positive trend allowing faster recognition and thus correction. I purposely went to 3 red/1 white, then 3 white/1 red, then to 2 red/2 white. I feel the system is a vast improvement from VASI."
2. "The visibility, intensity of PAPI is much greater than VASI. I particularly like knowing its location, touchdown aiming point, extremely useful. PAPI is a highly acceptable, flyable, visual landing aid. However, I would rather have a VASI on all non-ILS runways than PAPI on the runways that now have a VASI."
3. "One light low and high corresponded to exactly one dot low and high on ILS glide slope."
4. "Appears to be more definitive in close; i.e., inside the outer marker. Cannot be seen as far out as VASI."
5. "Biggest factors were ease of acquisition even at 10 nmi and rapid transition from red to white and back. I like it much better than conventional VASI."
6. "Easier to determine small excursions early in approach."
7. "Information is not as obvious as VASI."
8. "Requires horizontal plane scanning which is not normal during approach."

FIGURE A-1. QUESTIONNAIRE WITH NEWARK TEST RESULTS (Sheet 2 of 2)